MATERIAL SAFETY DATA SHEET

1. SUBSTANCE AND SOURCE IDENTIFICATION

National Institute of Standards and Technology
Standard Reference Materials Program
100 Bureau Drive, Stop 2320
Gaithersburg, Maryland 20899-2320

SRM Number: 3114
MSDS Number: 3114
SRM Name: Copper Standard Solution

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Description: This Standard Reference Material (SRM) is intended for use as a primary calibration standard for the quantitative determination of copper. Each unit consists of five 10 mL sealed borosilicate glass ampoules of an acidified aqueous solution prepared gravimetrically to contain a nominal 10 mg/mL of copper. The addition of copper to nitric acid forms copper nitrate, which will precipitate upon evaporation or drying of the solution; thus, the mixture has three components.

Material Name: Copper Standard Solution

Other Designations:

Copper: Cu
Copper Nitrate: Copper dinitrate**,** copper (II) nitrate, cupric nitrate, copper (2+) salt.
Nitric acid: Aqua fortis; hydronitrate; azotic acid; engraver's acid.

2. COMPOSITION AND INFORMATION ON HAZARDOUS INGREDIENTS

Component	CAS Registry	EC Number (EINECS)	Concentration (%)
Nitric Acid	7697-37-2	231-714-2	10
Copper Nitrate	3251-23-8	221-838-5	3.0
Copper	7440-50-8	231-159-6	1

EC Classification, R/S Phrases: Refer to Section 15, Regulatory Information.

3. HAZARDS IDENTIFICATION

NFPA Ratings (Scale 0-4): Health = 4 Fire = 0 Reactivity = 2

Major Health Hazards: Nitric acid can cause severe or fatal burns if inhaled, swallowed, or absorbed through the skin. Copper and copper compounds can irritate or burn the eyes, skin, and upper respiratory tract. Fever, chills, and/or lung X-ray changes may occur.

Physical Hazards: The glass container may shatter. Protect from physical damage and heat. Copper nitrate may explode when exposed to combustible materials.

Potential Health Effects

Inhalation: Nitric acid, if inhaled, can damage the mucous membranes and upper respiratory tract, causing spasm, inflammation of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Symptoms may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. Inhalation of copper or copper nitrate may irritate the mucous membranes and upper respiratory tract. Acute effects of copper dust or fumes may include fever and chills ("metal fume fever"). Prolonged exposure to copper dust may cause changes in lung X-rays, apparently without permanent damage.

Skin Contact: Nitric acid can cause severe skin burns. Effects of acid burns may be delayed. Contact with copper or copper nitrate may cause skin irritation. Copper nitrate may cause burns.

Eye Contact: Nitric acid can cause severe eye irritation, corneal burns, permanent eye damage, or blindness. Copper and copper nitrate may cause eye irritation. Copper nitrate may cause burns.

Ingestion: Nitric acid can cause severe burns and damage to the GI tract. Ingestion of copper or copper nitrate can cause stomach pains, vomiting, diarrhea, fever, and chills.

Medical Conditions Aggravated by Exposure: Nitric acid may aggravate pre-existing disorders of the eyes, skin, and respiratory system. Exposure to copper compounds may be particularly harmful to persons with Wilson's disease, a metabolic disorder in which excess copper is stored in the liver, kidneys, brain, and cornea. Copper may also aggravate other disorders affecting the kidneys, liver, and blood.

Listed as a Carcinogen/ Potential Carcinogen:

	Yes	No
In the National Toxicology Program (NTP) Report on Carcinogens		X
In the International Agency for Research on Cancer (IARC) Monographs		X
By the Occupational Safety and Health Administration (OSHA)		X

Exposure to some copper compounds may cause cancer, but the available data are inconclusive at present.

4. FIRST AID MEASURES

Inhalation: Move the person to fresh air immediately. Qualified medical personnel may start CPR or give oxygen if necessary. Get medical aid at once, and bring the container or label.

Skin Contact: Remove contaminated clothing and shoes. Flush affected skin with water for at least 1 minute, then wash thoroughly with soap and water. If burns are severe or if skin irritation persists, get medical aid and bring the container or label. Wash contaminated clothing before reusing.

Eye Contact: Remove contact lenses (if any). Do not allow victim to rub eyes or keep eyes closed. Flush eyes with large amounts of running water for at least 30 minutes, keeping eyelids open and raising lids to remove all chemical. Get medical aid at once, and bring the container or label.

Ingestion: Contact a poison control center immediately for instructions. Wash out mouth with water, but do not induce vomiting. Get medical aid at once, and bring the container or label.

Note to Physician (Nitric Acid): Wash affected skin with 5% solution of sodium bicarbonate ($NaHCO_2$). Activated charcoal is of no value. Do not give bicarbonate to neutralize the material.

Note to Physician (Copper): Calcium disodium EDTA may be given as a chelating agent.

5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: Although nitric acid does not burn, it is a powerful oxidizing agent that can react with combustible materials to cause fires. Copper nitrate is a negligible fire hazard, but it may also ignite or explode when exposed to combustible materials. A highly explosive peroxide deposit may form on copper metal exposed to air, and copper metal may also ignite on contact with certain incompatible materials, but the mixture does not present these hazards.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire: water spray, dry chemical, carbon dioxide, or foam. Use a water spray to dilute nitric acid and to absorb liberated oxides of nitrogen. (These guidelines apply to the mixture; when the components are considered separately, different precautions may apply.)

Fire Fighting: Avoid inhalation of material or combustion byproducts. Wear full protective clothing and NIOSH-approved self-contained breathing apparatus (SCBA).

Flash Point (°C): N/A

Autoignition (°C): N/A

Flammability Limits in Air: N/A

Lower Explosive Limit (LEL): N/A

Upper Explosive Limit (UEL): N/A

Flammability Class (OSHA): N/A

Products of Combustion: Thermal decomposition of nitric acid can release nitrogen oxides, including nitric oxide (NO), nitrogen dioxide (NO_2), and nitrous oxide (N_2O), as well as nitric acid mist or vapor. Thermal decomposition of copper nitrate may also release nitrogen oxides.

6. ACCIDENTAL RELEASE MEASURES

Occupational Release: Notify safety personnel of spills. Surfaces contaminated with this material should be covered with soda ash or sodium bicarbonate to neutralize the acid. Place the neutralized material into containers suitable for eventual disposal, reclamation, or destruction. Do not flush or release to the environment.

Disposal: Refer to Section 13, Disposal Considerations.

7. HANDLING AND STORAGE

Storage: Store unopened containers of this material in a dry place at room temperature. Protect from physical damage, heat, and light, and isolate from incompatible materials. Use opened containers immediately or discard.

Safe Handling Precautions: Wear gloves and chemical safety goggles (Section 8). Engineering controls should maintain airborne concentrations below TLV (Section 8).

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Nitric Acid:

ACGIH TLV-TWA: 5 mg/m^3
OSHA TLV-TWA: 5 mg/m^3

Copper and Copper Nitrate: No TLV-TWA has been established for copper nitrate or for most other copper compounds. The following exposure limits are for copper dust, mist, or fumes:

ACGIH TLV-TWA: 0.2 mg/m^3
OSHA TLV-TWA: 0.1 mg/m^3

Ventilation: Use local or general exhaust to keep employee exposures below limits. Local exhaust ventilation is preferred because it can control contaminant emissions at the source, preventing dispersion into the general work area. Refer to the ACGIH document *Industrial Ventilation, a Manual of Recommended Practices*.

Respirator: If necessary, refer to the NIOSH document *Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR 84* for selection and use of respirators certified by NIOSH.

Eye Protection: Use chemical safety goggles where dusting or splashing of solutions may occur. See OSHA standard (29 CFR 1910.133) or European Standard EN166. The employer should provide an emergency eye wash fountain and safety shower in the immediate work area.

Personal Protection: Wear appropriate gloves and protective clothing to prevent contact with skin.

9. PHYSICAL AND CHEMICAL PROPERTIES

Nitric Acid	Copper Nitrate	Copper
Appearance and Odor: Colorless to slightly yellow liquid, darkens to brown upon aging and exposure to light; irritating, pungent odor.	**Appearance and Odor:** Yellow to blue deliquescent crystal; odorless.	**Appearance and Odor:** Lustrous red crystal; odorless.
Relative Molecular Weight: 63.02	**Relative Molecular Weight:** 187.56	**Relative Atomic Weight:** 63.5
Molecular Formula: HNO_3	**Molecular Formula:** $Cu(NO_3)_2$	**Molecular Formula:** Cu
Specific Gravity: 1.0543 (10%)	**Specific Gravity:** 2.32	**Specific Gravity:** 8.92
Solvent Solubility: Decomposes in alcohol	**Solvent Solubility:** Soluble in ethyl acetate, dioxane, alcohol, and ether.	**Solvent Solubility:** Soluble in nitric acid, hot concentrated sulfuric acid, and hot hydrogen bromide; slightly soluble in hydrochloric acid and ammonium hydroxide.
Water Solubility: Soluble	**Water Solubility:** Soluble	**Water Solubility:** Insoluble
Boiling Point (°C): 86 (187°F)	**Boiling Point (°C):** 170 (338°F)	**Boiling Point (°C):** 2595 (4703°F)
Melting Point (°C): -42 (-43.6°F)	**Melting Point (°C):** 114 (239°F)	**Melting Point (°C):** 1083 (1981°F)
Vapor Pressure (Pa): 946 @20°C	**Vapor Pressure (Pa):** Negligible	**Vapor Pressure (Pa):** 133 @1628ºC (2962ºF)
Vapor Density (Air=1): 2.17	**Vapor Density (Air=1):** 8.33	**Vapor Density (Air=1):** N/A
Critical Solution Temperature: N/A	**Critical Solution Temperature:** N/A	**Critical Solution Temperature:** N/A
pH: 1.0 (0.1M solution)	**pH:** N/A	**pH:** N/A

NOTE: The physical and chemical data provided are for the pure components. No physical or chemical data are available for this solution of copper, copper nitrate, and nitric acid. The actual behavior of the solution may differ from the individual components.

10. STABILITY AND REACTIVITY

Stability: __X__ Stable _____Unstable

Stable at normal temperatures and pressure.

Conditions to Avoid: Contact with combustible or incompatible materials; prolonged exposure to air and moisture.

Incompatible Materials:

Nitric Acid: Incompatible with numerous materials including organic materials, plastics, rubber, chlorine, and metal ferrocyanide.

Copper Nitrate: Incompatible with strong bases, sodium, potassium, cyanide compounds, flammable and combustible materials, strong reducing agents, finely powdered metals.

Copper: Incompatible with numerous materials including acetylene, ammonium nitrate, bromates, 1-bromo-2-propyne, chlorates, chlorine, ethylene oxide, fluorine, hydrazinium nitrate, hydrogen peroxide, hydrogen sulfide plus air, hydrozoic acid, iodates, lead azide, oxidizers, phosphorus, potassium peroxide, sodium azide, sodium peroxide, and sulfuric acid.

Fire/Explosion Information: See Section 5.

Hazardous Decomposition: Thermal decomposition of nitric acid can release nitrogen oxides, including nitric oxide (NO), nitrogen dioxide (NO_2), and nitrous oxide (N_2O), as well as nitric acid mist or vapor. Thermal decomposition of copper nitrate may also release nitrogen oxides.

Hazardous Polymerization: _____ Will Occur __X__ Will Not Occur

11. TOXICOLOGICAL INFORMATION

Route of Entry: __X__ Inhalation __X__ Skin __X__ Ingestion

Nitric Acid:

Human, oral: LD_{Lo} = 430 mg/kg
Rat, oral: LD_{50} > 90 mg/kg
Rat, inhalation: LC_{50} (4 hrs) = 130 mg/m^3

Copper Nitrate:

Rat, oral: LD_{50} = 794 mg/kg

Copper:

Human, oral: TD_{Lo} = 120 µg/kg
Mouse, intraperitoneal: LD_{50} = 3.5 mg/kg

Target Organ(s):

Nitric Acid: skin, teeth, eyes, respiratory tract.

Copper and Copper Nitrate: skin, eyes, mucous membranes, respiratory tract.

Mutagen/Teratogen: Nitric acid has caused birth defects in animals under experimental conditions, and has been investigated as a possible mutagen. High levels of copper may reduce fetal growth in animals. Exposure to some copper compounds may cause mutations, but the available data are inconclusive at present.

Health Effects: See Section 3.

12. ECOLOGICAL INFORMATION

Nitric Acid:

Green shore crab (*Carcinus maenas*): LC_{50} (48 hrs) = 180,000 µg/L
Starfish (*Asterias rubens*): LC_{50} (48 hrs) = 100,000 to 330,000 µg/L
Hooknose (*Agonus cataphractus*): LC_{50} (48 hrs) = 100,000 to 330,000 µg/L
Brook trout (*Salvelinus fontinalis*): NR-LETH = 1,562 µg/L
Cockle (*Cerastoderma edule*): LC_{50} (48 hrs) = 330,000 to 1,000,000 µg/L

Copper Nitrate: No ecotoxicity data were found for this specific compound. See Copper, below.

Copper: Most copper released into the environment binds to particles of organic matter, clay, soil, or sand. Ecotoxicity data:

Eastern narrow-mouthed toad (*Gastrophryne carolinensis*): LC_{50} (7 days) = 40.0 µg/L
Earthworm (*Enchytraeus variatus*): LC_{50} (72 hrs) = 63.4 mg/L
Giant river prawn (*Macrobrachium rosenbergii*): LC_{50} (48 hrs) = 195 µg/L
Western mosquitofish (*Gambusia affinis*): LC_{50} (96 hrs) = 56.0 µg/L
Bluegill (*Lepomis macrochirus*): LC_{50} (96 hrs) = 1250 µg/L

Environmental Summary: The mixture is expected to be highly toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

Waste Disposal: One or more components of this mixture is a RCRA hazardous waste. Dispose of container and unused contents in accordance with federal, state, and local requirements for acid waste, which vary according to location. Decontaminate containers before recycling. Processing, use, or contamination of this product may change the waste management options.

14. TRANSPORTATION INFORMATION

U.S. DOT and IATA:

Nitric Acid: Hazard Class 8, UN2031, Packing Group II, Packing Instruction 807 (Excepted Qty)

15. REGULATORY INFORMATION

U.S. REGULATIONS

CERCLA Sections 102a/103 (40 CFR 302.4):

Copper: RQ = 5000 pounds.
Copper Nitrate: No RQ assigned (Category N100, Copper Compounds)
Nitric Acid: RQ = 1000 lbs.

SARA Title III Section 302: Nitric acid is regulated.

SARA Title III Section 304: Nitric acid is regulated.

SARA Title III Section 313: All three components are regulated.

OSHA Process Safety (29 CFR 1910.119): Nitric acid at higher concentrations (≥ 94.5%) is regulated.

SARA Title III Sections 311/312 Hazardous Categories (40 CFR 370.21):

ACUTE:	Yes
CHRONIC:	Yes
FIRE:	No
REACTIVE:	Yes
SUDDEN RELEASE:	No

STATE REGULATIONS

California Proposition 65: None of the components are regulated.

CANADIAN REGULATIONS

WHMIS Classification:

Nitric Acid: C (oxidizing material), D1A (very toxic material), E (corrosive material)
Copper Nitrate: C (oxidizing material), D2B (material causing other toxic effects)
Copper: D2B (material causing other toxic effects)

WHMIS Ingredient Disclosure List: All three components are regulated.

CEPA Domestic Substances List (DSL): All three components are regulated.

EUROPEAN REGULATIONS

EU/EC Classification:

Nitric Acid: O (Oxidizer), C (Corrosive)
Copper Nitrate: XN (harmful); not listed in Annex I of Directive 67/548/EEC.
Copper: XN (harmful); not listed in Annex I of Directive 67/548/EEC.

Risk Phrases (mixture):

R23 (toxic by inhalation)
R25 (toxic if swallowed)
R35 (causes severe burns)
R36/37/38 (irritating to eyes, respiratory system and skin)

Safety Phrases (mixture):

S20/21 (when using, do not eat, drink or smoke)
S28 (wash after contact with skin)
S45 (in case of accident or illness, see doctor; show label)
S60 (dispose of this material and its container as hazardous waste)

NATIONAL INVENTORY STATUS

U.S. Inventory (TSCA): All components are listed.

TSCA 12(b), Export Notification: No components are listed.

16. OTHER INFORMATION

Sources:

Amdur M.O., et al., *Casarett and Doull's Toxicology: The Basic Science of Poisons.* 4th Ed. New York: McGraw-Hill, 1993.

IUCLID Dataset: Copper. European Commission, European Chemicals Bureau, 19 February 2000.

IUCLID Dataset: Nitric Acid. European Commission, European Chemicals Bureau, 19 February 2000.

PAN Pesticide Database: Copper.

PAN Pesticide Database: Nitric Acid.

U.S. Environmental Protection Agency, Integrated Risk Information System (IRIS): Copper (CASRN 7440-50-8).

U.S. National Institute for Occupational Safety and Health, *NIOSH Pocket Guide to Chemical Hazards*, June 1990 edition. DHHS (NIOSH) Publication No. 90-117.

U.S. National Institute of Standards and Technology, *Certificate of Analysis: Standard Reference Material® 3114, Copper Standard Solution.* 14 June 2004.